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DISTAL EMBEDDING AS A TECHNOLOGY INNOVATION NETWORK FORMATION STRATEGY

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Abstract

Although the area of innovation economics dates back to the early twentieth century with the seminal contributions of Schumpeter (1911), it is only recently that governments have understood the role of a comprehensive approach towards public sector economics that puts innovation systems in the eye of public policy decision makers. Although well researched in academia in recent years, the role that innovation networks play in driving successful processes of innovation and entrepreneurship has been less understood by policy makers. Indeed, so far public policy makers have been concerned with the macro level of public policy in a way that has been rather "disconnected" from the meso level of innovation networks. Not surprisingly, overall strategies for innovation network formation have not been on the radar screen of public policy. The academic community, on the other hand, has been devoting more attention to the study of innovation networks in an attempt to understand the role they play as a catalyst of innovation and entrepreneurship. By and large in the research community, the process of innovation network formation has been left rather unattended. Indeed, the question of how these networks are formed and what strategies can be developed to ignite processes of innovation network formation has been largely absent from the academic debate. In this article, we make a contribution in this area and present "distal embedding" as one of three generic innovation network formation strategies. We also show why "distal embedding" is particularly well suited for emerging regions of innovation and entrepreneurship. Our contributions lie at the macro-meso interface and can shed light on public policy at the macro level aiming to have a direct impact at the meso level of innovation network formation.

Keywords: Entrepreneurship, innovation networks, innovation network strategy formation.

1. Introduction

The study of innovation networks and their role in enabling innovation and entrepreneurship has received considerable attention in the past decade (Uzzi 1996, Ahuja 2000; Podolny 2001; Sorenson and Stuart 2001; Bathelt et al 2004; Singh 2005; Sorenson and Stuart 2008). Other work has focused on network dynamics and evolution (Bresnahan and Gambardella 2004; Powell et al 2005; Newman et al 2006; Powell et al 2010; Ahrweiler2010).

Although there is today wide agreement on the importance of innovation networks for the success of innovation processes and entrepreneurship in knowledge-intensive industries, as recently documented by two of the most comprehensive studies of the networks of Silicon Valley (Ferrary and Granovetter 2009; Castilla et. al. 2000), considerably less attention has been devoted to the problem of innovation network formation (Kogut 2000; Casper 2007).

In this article, we make a contribution in this area by presenting “distal embedding” as a generic innovation network formation strategy. In Section 2, we begin by presenting evidence compiled by Ferrari and Granovetter (2009) showing the importance of such innovation networks, in particular the important role of venture capital firms in driving successful innovation and entrepreneurship processes. In Section 3, we present the comprehensive Neo-Schumpeterian model of public sector economics, the CNSE model put forth by Hanusch and Pyka (2007). In Section 4, we present the usual structural gaps of emerging regions of innovation and entrepreneurship and analyze these gaps using the public, financial and industry pillars of the CNSE model. In Section 5, we present distal embedding as an innovation network formation strategy and a model for implementing it. In Section 6, we describe some *ad-hoc* prior implementations of the distal embedding strategy. Though also applicable in robust regions of innovation and entrepreneurship, distal embedding is particularly well suited for emerging regions of innovation and entrepreneurship with the gaps described in Section 4. In Section 7, we present our conclusions and plans for future work.

2. An empirical study of the innovation networks of Silicon Valley

The empirical study conducted by Ferrary and Granovetter (2009) of the innovation networks in Silicon Valley has been one of the most comprehensive studies of complex technology innovation networks. Complexity in innovation network is defined in terms of the heterogeneity of the network, that is, the diversity of nodes with different functions in the network, and the multiplexity of its actors, that is, the different functions and roles a node can play in the network. In its empirical study, Ferrary and Granovetter consider that "complex networks show self-organizing behavior, that is, systemic behavior emerges dynamically through heterarchical multiplex interactions of agents in the network, and they also show resilient behavior, that is, they can withstand perturbations of the environment and keep its current functions or adapt to changing external conditions via learning, anticipation and innovation processes." In Table 1, we present the main results of Ferrary and Granovetter's empirical study.

Table 1: The role of VCs in complex innovation networks

Role	Importance	Characteristics
Financing	Essential to survive and accelerate growth during the first phases of the financial life cycle, from early-stage VC funding up to and through IPO. It also provides indirect funding to other nodes in the network	Exposure to high risk of the VC industry is mitigated by a complex structure of the network where deal syndication among "co-opeting'' VCs plays a major role in reducing this risk and enabling the VC industry
Selection	VCs select start-ups long before the market can and play a key role in choosing what start-ups will survive	Selection saves resources because only a small percentage of start-ups get funded
Signaling	VC funding does not guarantee success but sends a signal to other nodes in the network to interact with a VC-funded start-up	Start-ups that fail to raise funding from reputable VCs will compromise their chances to interact with other agents in the network
Learning	VC partners accumulate and diffuse knowledge that is relevant to make start-ups successful	Most entrepreneurs have no prior business and managerial experience
Embedding	A start-up that receives funding from a reputable VC gets embedded in the network	VC's multiplexity allows start-ups to get ``embedded'' in complex technology innovation networks

Source: Ferrary and Granovetter (2009)

The empirical study conducted by Ferrary and Granovetter (2009) paid special attention to the multiplex roles that the Silicon Valley venture capital industry plays in technology innovation and entrepreneurship in knowledge-intensive industries and unveiled the role of the venture capital industry in enabling innovation and entrepreneurship processes that have led to the creation of world-class companies in knowledge-intensive industries.

This study not only corroborated the complexity of the networks in Silicon Valley but also unveiled the important role venture capitalists play in these networks.

Indeed, venture capital firms in Silicon Valley are among the most complex nodes of Silicon Valley's innovation networks when it comes to complex network theory (CNT) measures such as betweenness centrality in the innovation network. The study also showed that venture capitalists play a multifaceted role in enabling entrepreneurship and creating world-class companies in knowledge-intensive industries.

Typically, the influence of tier-1 venture capital firms in helping entrepreneurs build world-class companies goes far beyond the complex innovation network where these entrepreneurs are located. As discussed in Section 5, venture capital firms will play a key role in the distal embedding innovation network formation strategy we are advocating for in this article.

3. The CNSE model: The need for a future orientation of the industrial, the financial and the public pillar

Comprehensive Neo-Schumpeterian Economics (CNSE) highlights the importance of the innovation and future orientation not only for the industrial sector in an economy but also for the financial and the public sector.

Without an adequate future orientation of the public sector the innovation activities of the industrial sector as well as the supply of resources from the financial sector are not sufficient to persistently spur economic growth and development.

Without doubt the field of entrepreneurial activities can be considered as an application *par excellence* for the CNSE approach. So far in the literature the decisive bottleneck made responsible for low or even missing entrepreneurial activities is malfunctioning or absent venture capital.

However, even a highly developed and efficient venture capital industry cannot compensate for deficits in the environment of the most innovative entrepreneurial companies. Innovation processes, in particular in knowledge-intensive industries, are characterized by a high degree of complexity.

On the one hand, single firms are hardly able to master all relevant technologies but have to focus on their core competences and the organization of the "interfaces" to exploit complementarities with the competences of other actors. On the other hand, innovation processes aimed at different industries are extremely time consuming. This long-term nature of the innovation processes requires for innovative firms to be embedded in stable network relationships with a heterogeneous set of partners comprising public research institutes, universities, small and large companies, venture capital firms – to name but a few.

For the public sector these complex innovation processes need an embedding environment for entrepreneurial activities with a pronounced future orientation, acknowledging the uncertainties of innovation and keeping in mind the long-term nature despite short-term cost considerations.

Obviously, in the creation of this environment the public sector can play an active role as network trigger and network enhancer (Schön and Pyka, 2012). In many instances, however, such an environment cannot be created, at least not in the short run, because of missing institutions, scarcity in (knowledge and financial) resources and a missing critical mass.

From this a vicious circle emerges because the low performance of entrepreneurial activities does not spur economic growth, which leads to a shortage in resources to create the required institutions to support entrepreneurial activities (Saviotti and Pyka, 2011).

In order to get out of this unholy alliance of missing future-oriented institutions and the shortage of resources leading to the inability to set up innovative new sectors by entrepreneurial activities, the public sector can drastically enhance its future orientation by adopting a Keokuk strategy that we have termed distal embedding. We explain this strategy in detail in Section 5. In Section 4, we outline the typical gaps found in emerging regions of innovation at the three pillars of the CNSE model.

4. Emerging regions of innovation and entrepreneurship

In analyzing emerging regions of innovation and entrepreneurship using the CNSE model, we often come across many of the characteristics shown in Table 2.

Typically, the gaps at the three pillars of the CNSE model, as introduced in Hanusch and Pyka (2007), have a compounded effect that prevents the innovations systems of these regions from adopting a future orientation approach. From a CNSE perspective, only the coordinated effort at the level of these three pillars can help overcome the problems associated with some of the gaps shown in Table 2. The process of bridging these gaps requires a long-term effort at the level of these three pillars though and is difficult to implement.

Table 2: Characteristics of emerging regions of innovation and entrepreneurship

Public Pillar	Industry Pillar	Financial Pillar
Low percentage of GDP invested in R&D	Low private investments in R&D	Lack of local venture capital industry
Low standards and no future orientation of the educational system	Lack of local talent in strategic technology management	No “enabling assets” that may attract investment of foreign VCs locally
Few and far between publicly-funded world-class applied R&D centers	Industry elite is successful competing domestically without innovation practices	Investors used to high returns from investments in traditional industries
R&D policies that encourage traditional push technology transfer models	Inbound industry innovation as opposed to outbound industry innovation strategy	Investor community focus on (financial) efficiency and not on effectiveness
Innovation policies favoring public investment in local non-knowledge-intensive industries following a reactive approach to exogenous factors	No best legal and consulting practices around IP management and transfer, corporate development, marketing and business development	Lack of local technology investment funds and no enabling assets that may attract foreign technology investment funds to invest in the region
Innovation policies promoting academic staff without world-class industry experience into management positions in the national innovation system	Lack of managerial talent that can bridge the gap between university base and applied R&D and early-stage technology management	Poor high-quality deal flow arising out of the local region of innovation and entrepreneurship
Policies that require investing in innovation agendas for domestic clients only	Small domestic market and/or lack of access to world-class clients	Lack of client funding for innovative projects

Ferrary and Granovetter (2009) argue that due to the systemic nature of complex innovation networks, the presence or absence of a few types of nodes in the network, especially those highly connected in the network, can seriously compromise the functioning of the network. Even though complex networks show particular resilience to changing conditions in the environment, the removal of highly connected nodes in the network can cause systemic failure (Newman et. al. 2006; Callaway et. al. 2000).

Even though we could argue that the innovation systems in many countries of emerging economies present less serious gaps than those presented in Table 2, the situation in which these countries are left is not radically different from the one in which countries presenting some or all the gaps in Table 2 are. Even for countries of emerging economies presenting less gaps in their national innovation systems, the task of closing these gaps and building complex innovation networks such as Silicon Valley is not feasible in the short and mid term.

With this in mind, we proceed to describe distal embedding as a network formation strategy that can be applied by countries of emerging economies to bridge these gaps in the short and mid term.

5. Distal embedding as an innovation network formation strategy

If we take the position that entrepreneurship and innovation in knowledge-intensive industries is a process that is not only determined by the entrepreneur Schumpeter (1911) and that the success or failure of innovation and entrepreneurship in these industries is primarily the result of multiplex interactions among diverse nodes in a complex innovation network, then the problem of network formation and the embedding of economic actors in those networks should become the main priority of actors in the public, finance and industry pillar of the CNSE model we briefly introduced in Section 4, which is described in detail in (Hanusch and Pyka, 2007).

In fact, the importance of developing a sound strategy for innovation network formation and the embedding of the actors in the three CNSE pillars should be a top priority for emerging regions of innovation and entrepreneurship.

The discussion of embeddedness in social structures and its impact on economic outcomes, originally raised in the seminal work of Granovetter in connection with the study of labor markets (Milgram 1967; Granovetter1973) and later expanded to other areas of economic life (Granovetter 1985; Granovetter 2005} pervades today a number of other areas in the social sciences. In particular, innovation and entrepreneurship is poised to benefit from a better understanding of the importance of complex innovation networks and the role they play in the outcomes of innovation processes (Uzzi 1996; Ahuja 2000; Podolny 2001; Sorenson and Stuart 2001; Bathelt et al 2004; Bresnahan and Gambardella 2004; Powell et al 2005; Powell et al 2010; Singh 2005; Sorenson and Stuart 2008; Ahrweiler 2010).

Our working assumption is that the national innovation systems of countries of emerging economies will present a range of gaps that will make it unfeasible for them to build complex innovation networks in the short and mid term. Without loosing generality, many of the gaps presented in Table 2 are shared by a wide variety of regions of innovation and entrepreneurship in many countries, even in highly developed countries.

We put forward the term “distal embedding'' to denote the embedding of nodes of emerging regions of innovation and entrepreneurship, that is, those regions that do not present the complexity required for innovation processes in knowledge-intensive industries to succeed, in innovation networks of “distant” regions of innovation and entrepreneurship that do present the complexity required.

It should be noted that distance in this context has a connotation that goes beyond geographic location and is to be construed as a measure of propinquity, as this term is defined in social and organizational psychology (Festinger et al 1950).

5.1 Emerging regions of innovation and entrepreneurship

Table 3 presents a subset of characteristics of an emerging region of innovation and entrepreneurship posing a major challenge for the implementation of robust innovation network formation strategy.

Emerging regions of innovation and entrepreneurship will typically have some of the characteristics described in Table 3. In these regions, the success of outbound innovation strategies, that is, strategies that orient themselves towards the creation of world-class technology companies exporting to the global technology absorption markets, will be severely impaired. In regions with the characteristics shown in Table 3, there is a natural bias towards implementing inbound innovation strategies, that is, strategies oriented at importing product and services developed in more developed countries. Using this inbound innovation strategy, the most innovative companies in the emerging regions of innovation and entrepreneurship tend to position themselves as value-added resellers and channel partners of leading foreign technology companies, helping them introduce their offerings in the domestic markets. Although in many of these emerging regions some of these companies can grow into large corporations using this strategy, few of them have attempted to adopt a peacefully co-existing outbound innovation strategy via the creation of business lines with offerings that can be exported to global markets.

Table 3: An emerging region of innovation and entrepreneurship

Public Pillar	Industry Pillar	Financial Pillar
Neoclassically inspired national technology innovation strategy	Disincentives for managers to pursue technical track record of excellence	Lack of local venture capital industry
Secondary and tertiary education has been largely privatized and left without future orientation	Lack of managerial talent in technology innovation both in industry and academia	Local investors not exposed to innovation processes of world-class innovation networks
Low investment in R&D as percentage of GDP	Risk-averse industry elite	Local investors not exposed to world-class technology management
Market failures regarding innovation remain largely unaddressed	Industry elite not used to competing through innovation	Local investors manage new ventures in knowledge-intensive industries as if they were managing new ventures in traditional industries

Most of the companies that attempt an outbound innovation strategy will typically fail due to lack of access to key enabling assets that are only available in complex technology innovation networks. Distal embedding is an innovation network formation strategy that can help entrepreneurs from emerging regions of innovation and entrepreneurship circumvent this problem.

5.2 The distal embedding process

The process of distal embedding is shown in Figure 1. The distal embedding strategy consists in "embedding" a node of an emerging innovation network (EIN) in a complex innovation network (CIN). For the strategy to function a so-called "embedding node" needs to exist in the CIN and the proper incentives need to be articulated by the EIN in order for the distal embedding to take place.

This strategy overcomes the problems that pervade EINs by way of allowing nodes embedded in EINs to access key enabling assets that are only available in CINs. In Figure 1, we borrow the diagram of the CIN from Ferrary and Granovetter (2009), a diagram that they use to describe the heterogeneity of the complex technology innovation networks of Silicon Valley.

In Figure 1, we introduce a special node, the so-called "embedding node," to perform the so-called "embedding function," the key function underlying this strategy.

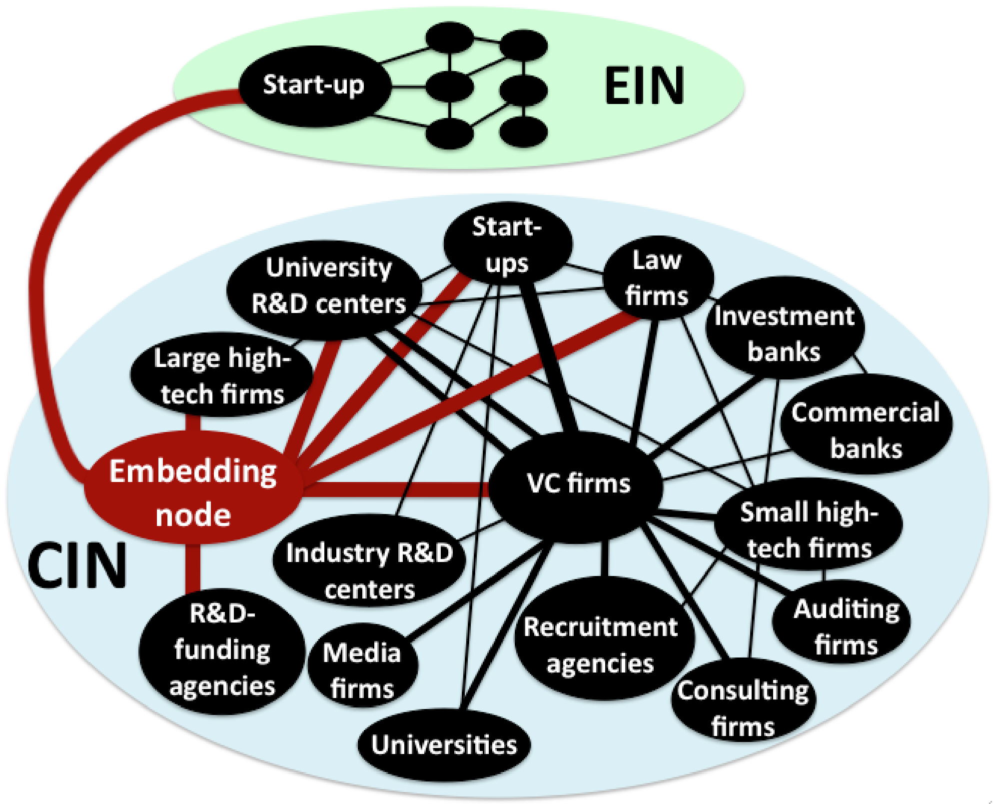

Figure 1: The process of distal embedding

5.3 Embedding nodes and their properties

A node embedded in a CIN can qualify as embedding node to the extent that it meets the following key criteria. The distal embedding strategy we are advocating for in this article is based on finding and engaging a suitable "embedding node" in the CIN and characterizing a compelling "embedding function."

Embedding nodes are a very special kind of node in a complex innovation network. To qualify as such, a potential embedding node needs to satisfy very peculiar conditions. Unlike VCs, embedding nodes do not typically have strong ties to a wide variety of nodes in the CIN, although weak ties may exist to many of them. Embedding nodes, though, must have strong ties to nodes that do possess these strong ties to other strongly connected nodes in the CIN, most notably to VCs or to nodes in the CIN with high degree of betweenness centrality. Embedding nodes typically do not provide financing, not in a direct way, but they can embed nodes of the EIN with nodes of the CIN that do provide such financing.

Table 4 provides a summary of the important functions that embedding nodes provide for EINs and CINs.

Table 4: The role of embedding nodes

Role	EIN	CIN
Financing	Embedding nodes do not fund nodes in the EIN but can provide access to nodes in the CIN that provide such funding, thus providing indirect funding to other nodes in the EIN	Once distally embedded, nodes of the EIN become nodes of the CIN and the embedding nodes play a role in granting access to sources of financing to them
Selection	Embedding nodes select start-ups in the EIN long before distally embedding them in the CIN, identifying nodes in the EIN with potential for global competitiveness, saving resources in the EIN	Distally embedded nodes undergo a selection process that saves resources in the CIN, particularly for VCs interested in funding start-ups originating outside the CIN
Signaling	Distal embedding sends a signal to nodes in the EIN to work with and fund distally embedded nodes in the EIN	Once distally embedded in the CIN, nodes become more likely to receive VC funding in the CIN
Learning	Embedding nodes are industry veterans that accumulate and diffuse knowledge required to create successful start-ups, providing the role of a non-funding super angel to nodes in the EIN	Embedding nodes also serve the process of accumulating knowledge about investing opportunities and technologies arising out of the EIN, diffusing this knowledge through the CIN
Embedding	A node from an EIN that gets distally embedded in the CIN by an embedding node gets embedded in the CIN	If distally embedded, nodes from the EIN are more likely to receive VC funding in the CIN and, if successful in receiving it, the embedding will get reinforced in the CIN

A necessary condition for an embedding node to qualify as such is that it has to be a source of influence in the CIN, typically because: (i) they have access through strong ties to nodes in the CIN that exert such power in the network and (ii) they can influence the decision-making processes made by powerful and influential nodes.

5.4 Embedding functions

At the core of the distal embedding strategy is the so-called embedding function. An embedding function is defined as a function of the embedding node that embeds nodes of the EIN in the CIN. The availability of such an embedding function depends on whether or not a “compelling value proposition” can be articulated between the embedding node in the CIN and the nodes in the EIN that are seeking to be embedded in the CIN. In some cases, not the actors seeking such embedding provide the "enabling assets" for the embedding function to exist. Indeed, actors from the public or finance pillars such as government agencies or venture capital firms, respectively, can act on behalf of the actors of the EIN for which the embedding is intended and provide the "enabling assets" for this value proposition to be articulated.

It should be noted that the embedding function creates a strong tie between the embedding node in the CIN and the embedded nodes in the EIN. Such a strong tie can be created only if a vested interest is created for the embedding node to engage on a long-term basis in the embedding process such that: (i) a high-value creation process ensues in the CIN, and (ii) the embedding node can capitalize upon that process of value creation.

Invariably, the embedding node will need to embrace the risks associated with the *ex ante* possibility of failure and losses. This will make it necessary for the value proposition underlying the embedding function to provide the necessary upside potential for the embedding node to assume this risk. If this is not the case, a suitable embedding function will in all likelihood not be articulated and the embedding process will not be executed well or will not take place at all.

In the next section, we survey some cases of distal embedding. In so doing, we identify the embedding and embedded nodes, the embedding functions and the associated enabling assets that led to the articulation of a compelling value proposition. Some of these cases of distal embedding originated in "singularity events" that gave rise to extraordinary enabling assets, which in turn created extremely compelling value propositions that led to the creation of strong embedding functions.

6. Implementing the distal embedding strategy

6.1 Ad hoc cases of distal embedding

The lack of comprehensive models of distal embedding makes it not surprising at all that many of the cases of distal embedding observed so far have unfolded rather spontaneously. They have not been the result of executing a comprehensive public policy agenda driven by governments (public pillar), nor the result of a process of strategic planning and execution at the corporate level (industry pillar), nor the result of a coordinated effort of those actors providing financial backing (the finance pillar). Accordingly, we term them as *ad hoc* cases of distal embedding.

6.2 The case of Israel

Perhaps the most salient case of distal embedding has been implemented by Israel for very singular reasons. Indeed, if we review the criteria in Table 3, we find out that Israel does not qualify as the quintessential country for a distal embedding strategy. A second glimpse at the singular conditions of Israel reveals that some constraints in its industry pillar, in conjunction with other characteristics of its public and particularly its finance pillars, make the distal embedding strategy an ideal strategy to circumvent the shortcoming of Israel's national innovation system. Table 5 summarizes some of the conditions of the national innovation system in Israel.

Table 5: The singular conditions of Israel

Public Pillar	Industry Pillar	Financial Pillar
High percentage of GDP invested in R&D	Low private investments in R&D	World's highest per-capita venture capital spending
Future orientation of educational system	Lack of local talent in strategic technology management	No assets that may attract investment of foreign VCs locally
Several publicly-funded world-class applied R&D centers	Industry elite is used to competing through innovation practices	Investors used to high returns from investments in non-traditional industries
R&D policies that encourage traditional push technology transfer models	Outbound industry innovation strategy	Investor community transitioning from a focus on efficiency to a focus on effectiveness
Innovation policies favoring public investment in local knowledge-intensive industries following a proactive approach	Some mass of legal and consulting practices around IP management and transfer, corporate development, marketing and business development	Local technology investment funds are plentiful but the lack of other enabling assets has prevented foreign technology investment funds from investing in the region
Innovation policies promoting investment in applied R&D through open innovation	**Small domestic market and/or lack of access to world-class clients**	**High-quality deal flow arising out of the local region of innovation and entrepreneurship but lack of funding of innovative projects by local clients**

Israel holds one of the world's highest per-capita VC funding rates and one of the world's highest rates of investment in R&D, has a number of world-class R&D centers producing cutting-edge IPs, and has invested in a local environment where technology entrepreneurship and innovation thrive. From this perspective, Israel is quite a departure from the situation of most countries of emerging economies. Indeed, Israel's would be in all likelihood very well positioned to execute other innovation network formation strategies such as replication and local embedding, both of which are described elsewhere (Paredes-Frigolett and Pyka, 2012), if it were not for some very singular conditions that make such course of action untenable. In fact, Israel's need for a distal embedding strategy stems from its geopolitical location, the lack of a large domestic technology absorption market, and the lack of access to requirements from world-class customers in key vertical markets.

The implementation of distal embedding executed by Israel is also somewhat singular in that the distal embedding process did not take place initially by identifying an embedding node in a complex innovation network. In the absence of such an embedding node, many Israeli start-ups attempted a process of “self-embedding,” which by definition is an impossibility. Indeed, since most Israeli start-ups realized very early on in the innovation life cycle the need to access the largest technology absorption markets, they “disembarked” in complex innovation networks such as the “128 corridor” around Boston or Silicon Valley in the Bay area in an attempt to get themselves “self-embedded” in those networks.

In so doing, they have been financially backed by VCs based in Israel, which for all intent and purposes assumed the role of embedding nodes in our model. Not being themselves embedded in those complex networks, Israeli VCs did not qualify as suitable embedding nodes. As a result, no embedding functions could be articulated and the distal embedding process could not take place.

Most successful technology start-ups in Israel were initially funded by local VCs in the EIN (Israel). Israeli VCs are insofar a rare breed as they have specialized themselves in funding early-stage deals, which in complex innovation networks such as Silicon Valley has long become a relic of the past. Given the need for distal embedding, local VCs in the EIN typically incorporate subsidiaries in a CIN such as Silicon Valley, keeping R&D, engineering and back-office operations locally in the EIN.

Unfortunately, this indirect process does not distally embed the U.S. subsidiaries of Israeli start-ups in the CIN. As a result, Israeli start-ups, and the VC that backed them, engaged in a long and tedious process of establishing and nurturing ties with other actors in complex innovation networks such as Silicon Valley on their own. For the great majority of them this process did not yield results because of the lack of an "embedding node" actively engaged in the distal embedding process throughout the innovation life cycle in the CIN.

Despite the lack of a successful distal embedding strategy, the large number of Israeli start-ups financially backed by local (Israeli) VCs with the potential to become world-class companies has had such a critical mass that Israel, in particular its local VCs community, has been able to produce some compelling cases of technology companies that have gone public in NASDAQ and have become world leaders. Another factor that has contributed to this process of establishing those ties is the compelling flow of "fundable deals" arising out of Israel.

These singular events combined have attracted the attention of tier-1 VCs in Silicon Valley in such a way that strong ties between these two communities have begun to emerge. This has contributed to the creation of ties between the local VC community in Israel and tier-1 VCs in Silicon Valley. As a result, and after a long process that unfolded over the last two decades, the conditions for distal embedding have only now begun to emerge to a point where the process of distal embedding of start-ups financially backed by Israeli VCs can now be attempted in a more systematic way along the lines of the model outlined in this article.

From the perspective of our distal embedding model, the rise of highly visible and successful technology companies out of Israel and the compelling flow of "fundable deals" arising out of that region constitute the enabling assets that Israel has been able to develop in order to articulate a compelling value proposition for the embedding nodes.

In this case, the embedding nodes correspond to tier-1 VCs in complex innovation networks such as Silicon Valley. The embedded nodes correspond to the Israeli VCs themselves and, through them, the Israeli start-ups they fund. The embedding function in this case is achieved through a process of deal syndication, with the Israeli VCs providing seed, angel and super angel funding in the EIN and then syndicating a series A round of equity financing later on in the financial life cycle in the CIN. This process is typically accomplished through a subsidiary incorporated in the U.S. with the Israeli VC acting as lead investor. The Israeli VC then syndicates the deal with a tier-1 VC in the U.S, which in turn acts as accompanying investor. From then on, the process continues as usual, with other rounds of equity financing being syndicated by both the Israeli and the local VC in the CIN. After the first series A round, the tier-1 VC in the complex innovation network assumes the role of lead investor in subsequent rounds of funding. So in the particular case of Israel, the embedding of Israeli VCs through strong ties to tier-1 VCs in places such as Silicon Valley constitutes the “enabling asset” that makes distal embedding a viable strategy for Israel today.

6.3 Another *ad-hoc* case of distal embedding

Another singular case of distal embedding emerged spontaneously in the ITC industry in connection with the millennium bug. In this case, the distal embedding followed a pattern similar to the one described in Figure 1. In this case, the Big 5 consulting companies provided the embedding node.[1] Through this process of distal embedding, enterprise software vendors that operated regionally throughout the nineties such as SAP became global leaders in a relatively short period of time. This example shows the importance of embedding nodes for the successful execution of the distal embedding process.

In this second case, the embedding nodes not only did exert strong influence on the purchasing decisions of the largest corporations in tier-1 markets in North America, EMEA and APAC but also in tier-1 markets in Latin America. At the same time, they had a vested interest in the success of the embedding function. The embedding function, on the other hand, did require a change in the revenue model of emerging enterprise software vendors such as SAP.

Prior to this successful case of distal embedding, the revenue model of the world’s largest enterprise software vendors consisted in selling software licenses and professional services. The need of the embedded nodes (the enterprise software vendors) to characterize a compelling value proposition for the embedding nodes (the Big 5 consulting firms) did require a change in the revenue model of the vendors. This was a necessary component of the value proposition in order for the embedding nodes to have a vested interest in executing the embedding function.

Some enterprise software vendors with already established consulting organizations as their main source of revenues were unwilling to relinquish the consulting revenue source by adopting the new revenue model. Other smaller vendors did adopt the new revenue model and were therefore able to create a compelling value proposition for the

[1] This is a term used to refer to the largest professional services firms that provide consulting services in strategy and management, including ITC strategy and execution, to the largest corporations of the world.

embedding nodes, that is, for the Big 5 consulting companies. With such distal embedding function in place, the embedding nodes did actively engage and successfully execute a distal embedding function for these smaller vendors.

It is interesting to note that smaller enterprise software vendors did have an advantage over larger vendors in the U.S. due to the dilemma of creative destruction. With a large consulting organization in place actively engaged in deployments in the largest ITC absorption markets, established companies in the enterprise software market did face the dilemma of destroying a successful revenue model and change their organizational structure in order to accommodate the requirements of the Big 5 consulting firms. Smaller vendors were more prone to accepting a change in the revenue model and were therefore able to characterize a compelling value proposition for the Big 5 consulting firms, which led to a process of creative destruction in the entire enterprise software industry.

Through this process of distal embedding, smaller enterprise software vendors were able to have access for the first time to requirements of large corporations in the world's largest technology absorption markets. In a way, this not only provided access to client financing but also to requirements from world-class clients in regions of innovation that were not easily accessible to them prior to this process of distal embedding. The embedding nodes, that is, the Big 5 consulting firms, did deploy vast resources through their subsidiaries in these tier-1 technology absorption markets, providing *de facto* not only a vast consultative sales force throughout the world to qualify and close very large license deals for the vendors but also execution power in order to successfully deploy large enterprise software integration projects at the world's largest corporations, rendering them key reference accounts in the process.

7. Conclusions

In this article, we have described distal embedding as one of three generic innovation network formation strategies (Paredes-Frigolett and Pyka, 2012). This work characterizes the process of embedding of nodes in innovation networks as the central element towards innovation network formation.

As argued by other researchers, the complexity of innovation networks or lack thereof is one of the key elements that impacts on the chances of success of processes of innovation and entrepreneurship taking place in such networks. Unlike other research in this area, we have focused not on the study of such networks but on the rather elusive problem of how the process of innovation network formation takes place. Part of our work focuses on generic strategies that can be implemented in order to increase the chances of success of innovation processes taking place in innovation networks lacking the necessary complexity.

As mentioned, the concept of embedding plays a central role in this connection. Indeed, the possibility of a node embedded in an emerging region of innovation and entrepreneurship to effectively get embedded in a complex innovation network is a key factor in our model that plays a central role in determining the economic outcome of an innovation process.

The process of distal embedding, as defined in this article, is not only interesting for emerging regions of innovation an entrepreneurship of developing countries, especially those that are not endowed with local assets to successfully enable and execute a process of local embedding, as described by Paredes-Frigolett and Pyka (2012). Distal embedding can also be used in regions of innovation and entrepreneurship of developed countries. The second case of distal embedding described in Section 6 is a good example of this.

Albeit in an *ad hoc* way, this second case of distal embedding took place in one of the most industrialized regions of Europe, a region that is notorious for having formed some highly complex innovation networks in several industries. This case followed closely the model of distal embedding we introduced in Section 5. It is interesting to note that once all the components had been put in place for the embedding function to be characterized and executed, the distal embedding process unfolded rapidly and produced high-impact results in relatively short period of time. In the case of software vendors such as SAP, the results were of such magnitude that the company became a world-class company and eventually the world's largest enterprise software vendor in less than a decade.

The distal embedding process executed by Israel did not follow the model proposed in this article. In the absence of a proper embedding node and an associated embedding function, distal embedding could not take place initially. This can be characterized as a brute force approach to distal embedding that in the end has proven to be successful due to the continuous investment of the finance and private pillars in the Israeli innovation system over a long period of more than two decades, on the one hand, and some singular events and conditions of the innovation systems in Israel that are very unique difficult to replicate, on the other.

In the second case of distal embedding discussed in Section 6, the engagement of an embedding node, in this case comprised of the global consulting organizations of the Big 5 consulting firms, caused the process of distal embedding to occur in a relatively short period of time, mobilized and leveraged enormous resources located outside the network in which the organization being embedded was located, and effected a transition of the embedded company from being a regional player in the DACH region[2] to becoming the world's largest enterprise software vendor in less than a decade.

While the examples above did not follow a systematic approach to distal embedding but rather unfolded spontaneously, they demonstrate the feasibility of distal embedding as a process of innovation network formation. The second case, in particular, is the quintessential manifestation of an *ad hoc* distal embedding process. Even though this process did not follow a systematic model of distal embedding, this second case exemplifies the impact that a process of distal embedding can have on the economic outcomes of an innovation process. The magnitude of the success of this second case was predicated on the magnitude of the singular event that gave rise to its process of distal embedding.

We might argue that the actors involved in these cases of distal embedding were unaware of what mechanism was at work and how this mechanism operated, although they were very much aware of the results this mechanism was producing. But these successful cases of distal embedding prove that there is a mechanism at work behind the embedding.

We claim that there is method behind the magic of distal embedding and that technology companies from both robust and emerging regions of innovation can benefit from understanding how the process of distal embedding works and how a distal embedding strategy can be implemented and executed.

Current and future work consists in putting forward a comprehensive framework of innovation network formation based on generic innovation network formation strategies (Paredes-Frigolett and Pyka, 2012) and in developing a biologically inspired general theory of innovation network formation (Paredes-Frigolett, 2012).

[2] DACH is an acronym used in German-speaking countries that stands for Germany, Austria and Switzerland.

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